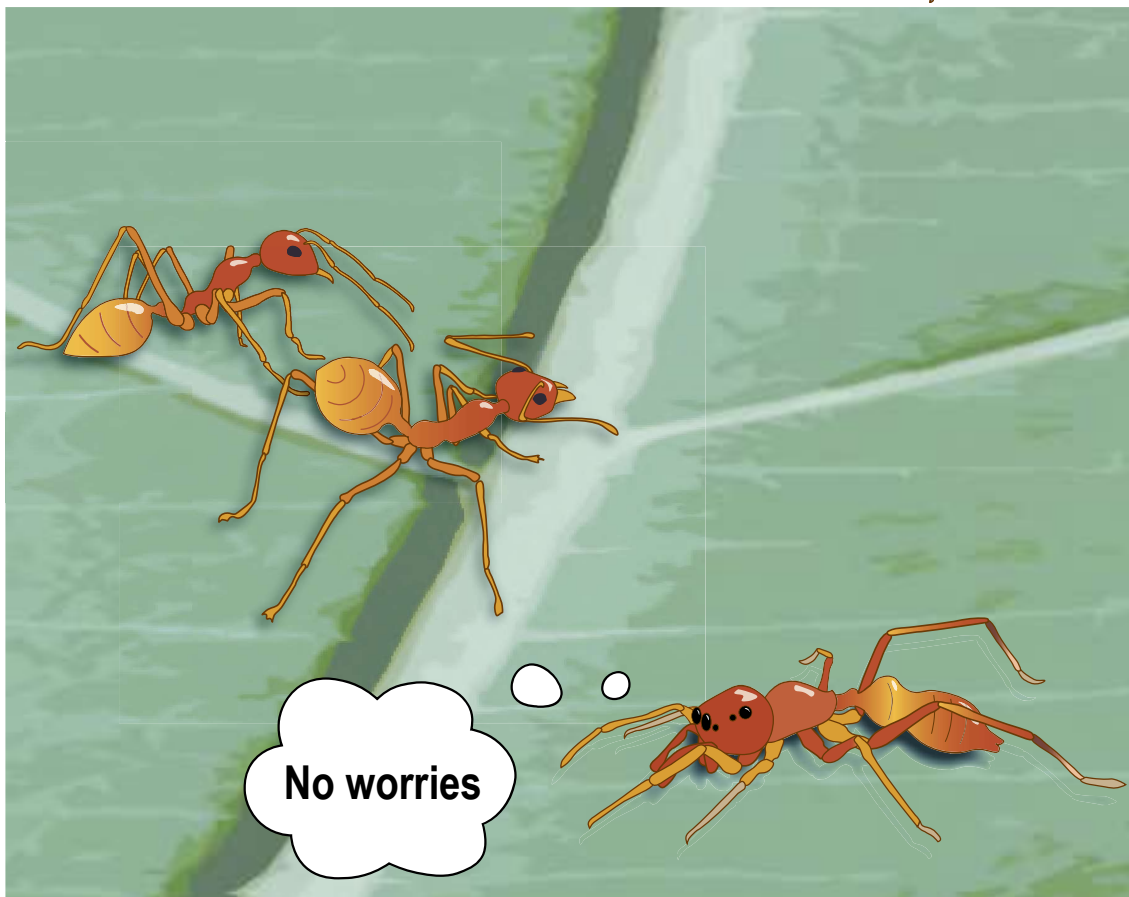
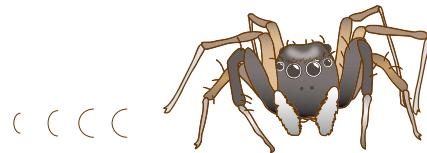


SATREPS-PUBS The 2nd WORKSHOP

ABSTRACT BOOK



**15 November 2022
@ UCSI Hotel Kuching & Online**

Cover: Weaver ants and a weaver ant-mimicking jumping spider on the same leaf. The main natural enemy is non-mimicking jumping spiders, but the ant-mimicking jumping spider is rarely attacked by predators because it mimics the aggressive weaver ant precisely (but it has eight legs!) Illustrations by Fumi Hayashi.



PUBS SATREPS Sarawak-Japan 



KYOTO UNIVERSITY

SATREPS-PUBS The 2nd Workshop

15 November, 2022

All times in Malaysia Time (UTC +8). Japan time is one hour ahead (UTC +9).

9:00-9:30 | Opening remarks & Plenary

Dr. Takao Itioka

Professor, Graduate School of Human and Environmental Studies, Kyoto University

Title: The key activities in the project finally started! Report on the progress status and the future outlook

9:30-11:50 | Progress from Master and PhD candidate

students & Postdocs

Ms. Khairunnisa Binti Othman

Master's Program (Environmental Management), Kyoto University
Research Officer, Forest Department Sarawak

Title: Effects of Myrmecophytism on Species-diversity of Phyllosphere Microfungi on *Macaranga* sp. at two Sarawak Lowland Forests

Ms. Ajuwin Lain

Master's Program (Environmental Management), Kyoto University
Research Officer, Sarawak Biodiversity Centre

Title: Biodiversity and Endemism of Ectomycorrhizal (ECM) Fungi Inhabiting the Forest Ecosystem in Sarawak

Ms. Jamilah Binti Hassan

Master's Program (Environmental Management), Kyoto University

Research Officer, Sarawak Biodiversity Centre

Title: Elucidation of Diversity for Wood-decaying Fungi in Sarawak

Mr. Clement Het Kaliang

Conservation Officer, Sarawak Forestry Corporation

PhD Candidate, Graduate School of Global Environmental Studies, Kyoto University

Title: Temporal trends in populations of phytophagous hemipteran insect species in a Bornean tropical rainforest

Ms. Voon Mufeng

Wildlife Officer, Sarawak Forestry Corporation

PhD Candidate, Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University

Title: "Clouds in the highlands? Yes, and it includes leopards" - A research plan

Dr. Yosuke Kojima

Postdoctoral Researcher, Graduate School of Human and Environmental Studies, Kyoto University

Title: Progress of behavioural studies on reptiles and amphibians of Sarawak

Dr. Takafumi Mizuno

Expert, Japan International Cooperation Agency (JICA)

Postdoctoral fellow, Graduate School of Human and Environmental Studies, Kyoto University

Title: Curation of insect specimens for a study of population dynamics of Carabid beetles

11:50 – 13:30 | Lunch break

13:30-14:50 | Research highlights

Dr. Tomoaki Ichie (online)

Professor, Kochi University

Title: Identification of tree age and growth rate by using xylem $\Delta^{14}\text{C}$ in aseasonal tropical forests

Ms. Bibian Diway

Forest Department Sarawak

Title: New locality and bud growth of the world biggest flower, *Rafflesia tuan-mudae*, in Naha Jaley, Sarawak, Malaysia

Dr. Yoshiaki Hashimoto

Professor, University of Hyogo

Title: Mimicry constraints on the jumping and prey-capturing abilities of ant-mimetic jumping spiders (Myrmarachne, Salticidae) - Through the Looking-Glass: reflection of ant-diversity in ant-mimics

Dr. Kanto Nishikawa

Associate Professor, Graduate School of Human and Environmental Studies, Kyoto University

Title: Recent progress of systematic studies on amphibians and reptiles from Sarawak

14:50-16:10 | Progress from core subprojects

Dr. Satoshi Yamashita

Senior Researcher, Center for Biodiversity and Climate Change, Forestry and Forest Products Research Institute

Title: Biodiversity survey manual: PUBS-SATREPS

Dr. Usun Shimizu-kaya

Assistant professor, Faculty of Life and Environmental Science, Shimane University

Title: Digitalization on biodiversity studies: specimen collections and plant phenology observation

Dr. Hirotoshi Sato

Assistant professor, Graduate School of Human and Environmental Studies, Kyoto University

Title: Toward the active use of high throughput sequencing in Sarawak

Dr. Shinya Numata

Professor, Department of Tourism Science, Tokyo Metropolitan University

Title: System development for wildlife tourism and conservation in protected areas with rainforests

16:10 | Closing remarks

Mr. Jack Liam

Deputy Director, Forest Department Sarawak (Forest Conservation and Development)

The key activities in the project finally started!:

report on the progress status and the future outlook

Takao ITIOKA^{1*}

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Abstract:

After the two and a half year of "hibernation" forced by the Covid-19 pandemic, we finally started our PUBS research activities in Sarawak three months ago.

A type of inclusive field survey for unveiling the entire biodiversity in the protected area is called SBPS (Survey for Biodiversity in the Protected areas in Sarawak), which is one of the key activities of our project, PUBS. In SBPS, various types of surveys with various methods targeting various taxa in the wide range of organisms, including insects, fungi, plants and vertebrates are conducted in the field at more than 15 protected areas all over Sarawak in collaboration with Sarawakian and Japanese researchers studying the wide range of academic fields. In late August this year, we conducted a group survey at Santubong National Park as the first event of SBPS and at Lambir Hills National Park as the second event. In this talk, I will report how the SBPS events were going, with a brief explanation of future SBPS plans and some research subjects closely related with SBPS.

In parallel to the beginning of SBPS, development of infrastructure and research facilities for strengthening research in biodiversity sciences, which is another key activity of our project, has significantly advanced. Various types of equipment, such as the next generation DNA sequencers (NGSs), their peripheral equipment, deep-freezers, microscope, and digital microscope with 3-D image scanning function, that provide powerful support for Sarawakian's research on the biodiversity sciences were introduced to the three research organizations, FDS, SFC and SBC, from late July to October, 2022. In the talk I will also explain about the functions and merits of various devices of the research equipment not only in the academic fields of biodiversity sciences, but also in the multi-purposes of people in the wide range of Sarawak society outside the academic fields when utilizing findings from research activities in biodiversity sciences as intellectual resources, with a brief introduction of research plans to be implemented in the near future under PUBS.

Keywords: biodiversity sciences, capacity building of scientific research, National Parks in Sarawak, Official Development Assistance, PUBS (SATREPS-JST/JICA)

Effects of Myrmecophytism on Species-diversity of Phyllosphere Microfungi on *Macaranga* sp. at two Sarawak Lowland Forests

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Abstract: The genus *Macaranga* belongs to the family Euphorbiaceae, one of the largest families of Angiosperms. It comprises both myrmecophyte and non-myrmecophyte species. The myrmecophytism provides the plants with protection against herbivore damage, vine covers, and pathogens. Ants are known to secrete antimicrobial substances from the glands on the body surface and then the substances are expected to have significant influences on species compositions of phyllosphere fungi on leaves of *Macaranga* myrmecophytes. Phyllosphere fungi include not only species that provide negative effects on growth performance in the host plants as pathogens but also those that provide positive effects as mutualistic symbiont microbes. Therefore, species compositions of phyllosphere fungi and the effects of myrmecophytism on the species compositions should be important for the understanding of growth, survival process, fitness, and dynamics of an interactive process between plants and plant-ants. This study aims to clarify the effects of plant-ant presence on the phyllosphere microfungal community of *Macaranga* in Sarawak by comparing the species-compositions of fungal community between myrmecophytic and non-myrmecophytic species, using Illumina MiSeq sequencing system as well as to evaluate variation in phyllosphere fungal diversity between areas. To achieve the aim, so far, *Macaranga* leaf samples have been collected from 85 *Macaranga* individuals belonging to 9 myrmecophytic species and 3 non-myrmecophytic species in Santubong National Park and Lambir Hills National Park.

Keywords: ant-plant interactions, ant-fungus interactions, Borneo, fungal diversity, phyllosphere microorganisms, tropical rainforests

Biodiversity and Endemism of Ectomycorrhizal (ECM) Fungi Inhabiting the Forest Ecosystem in Sarawak

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Abstract: Ectomycorrhizal (ECM) fungi involved in obligatory symbiosis with several major tree families are invaluable to most forest ecosystems. Most studies on the ecology and biodiversity of ECM fungi have focused on temperate forests in the Northern Hemisphere. Thus, little is known about ECM fungal communities in tropical ecosystems, particularly in the pale tropical rainforests of Southeast Asia, which are characterized by a high abundance of ECM host trees. We need to extend our current knowledge about the biodiversity of ECM fungi in tropical rainforests to understand the global biodiversity of ECM fungi better. Therefore, this study aims to examine species diversity and endemism of ECM fungi inhabiting tropical rainforests in Sarawak and to understand factors that determine the biogeography of ECM fungi. The investigation was conducted in tropical rainforests consisting of dipterocarp and fagaceous trees. To perform the above-mentioned research scheme, ECM samples (plant roots) were collected on targeted plant families (Dipterocarpaceae and Fagaceae) by field survey in forests of the national parks of Sarawak. Then, the DNA barcoding approach is attempted to perform species identification of both ECM fungi and host plants from ectomycorrhizal samples. Based on the obtained DNA sequences, the diversity and endemism of ECM fungi inhabiting tropical rainforests in Sarawak are evaluated.

Keywords: Ectomycorrhizal, Fungi, Tropical Forest, Sarawak

Elucidation of Diversity for Wood-decaying Fungi in Sarawak

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2 Center for Biodiversity and Climate Change, Forestry and Forest Products Research Institute,
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Abstract: Polypore fungi play an important role as wood decomposers and pathogens in forest ecosystems. They produce large, easy-to-see fruiting bodies that last for a long time, thus acting as indicators of human impact on forest ecosystems. *Ganoderma* and *Amauroderma* are polypore fungi that are widely distributed in temperate and tropical forests. *Ganoderma australe* and *Amauroderma subrugosum* are common species in lowland areas of Sarawak. *Ganoderma australe* forms its fruiting bodies on the trunks of living or dead trees, while *A. subrugosum* forms its fruiting bodies on the ground, most probably using buried dead trunks or roots. The objective of this study is to delimit the species of these two fungi and to determine the diagnostic morphological characteristics and interspecific differences in ecological traits (e.g., habitat of fruiting bodies). The fruiting bodies of *G. australe* and *A. subrugosum*, as well as related species, were collected from decayed logs, dead trunks, and buried dead roots in the three national park areas (Santubong, Kubah, and Lambir Hill) in Sarawak, Malaysia. A total of 278 fungal fruiting bodies were collected and identified based on morphological characteristics, including phylogenetic analyses of DNA sequences. DNA amplification of the collected material will estimate species boundaries using molecular phylogeny and population genetic approaches. Finally, diagnostic morphological characteristics and ecological traits of each species will be evaluated.

Keywords: wood-decaying, fungi, national park, Sarawak, *Ganoderma*, *Amauroderma*

Temporal Trends in Populations of Phytophagous Hemipteran Insect Species in a Bornean Tropical Rainforest

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Abstract:

Bornean lowland forests as habitats for insects are characterized by extremely weak seasonality in climate with everlasting high temperature and high humidity. The seasonalities in life history and temporal population trends have not been elucidated for most of the arthropod species there. It remains unclarified how they adjusted their life histories or population growth to the weak seasonal patterns in the climate. Bornean lowland forests as arthropod habitats are also characterized by community-level synchronous reproductive masting (CSR) in tree assemblage, called general flowering. And, it also remains unclarified how do insect species respond to occurrence of masting reproduction except for some species of several insect taxa. So far, temporal fluctuations in abundance of several insect taxa, such as some species in two phytophagous coleopteran families, Chrysomelidae and Scarabaeidae, those in a xylophagous coleopteran family, Passalidae, and the giant honey bee (*Apis dorsata*) had been determined in relation to temporal patterns in climatic conditions and occurrence of CSR. In this study, we are going to focus on the temporal fluctuating patterns of phytophagous hemipteran in responds to the temporal patterns of climatic conditions and CSR occurrences. Hypothetically, differences in basic biology, especially for the food habit, between phytophagous coleopterans and the target phytophagous hemipterans were expected to have a relatively significant effect on their temporal patterns. Under the PUBS, to examine the hypothesis, I have targeted phytophagous hemipteran species the huge number of specimens of which were collected from a series of monthly light trapping conducted in Lambir Hills National Park for more than six years. As it is necessary for quantitative analyses on the temporal trends at species level, we are going to apply molecular techniques by using the NGS, in addition to species identification as morphospecies under the microscope.

Keywords: Hemiptera, phytophagous insects, population fluctuation, population dynamics, supra-annual climatic variation.

"Clouds in the highlands? Yes, and it includes leopards" - A research plan

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Abstract: The largest predator on the Borneo Island is the Bornean Clouded Leopard (*Neofelis diardi borneensis*), a subspecies described in 2011, along with the Batu-Sumatran subspecies (*Neofelis diardi diardi*). The *N. diardi borneensis* is native to Borneo and is distinctly different from its mainland cousin *Neofelis nebulosa*. Unlike *N. nebulosa*, the Bornean Clouded Leopard is still understudied and although researchers have started to look into the spatial ecology and genetics aspects of the species, there are still a lot of research gap that needs to be bridged urgently, with the subspecies currently listed as Vulnerable in the IUCN Red List. This paper outlined the research plan to close some of the gaps by investigating the multi-faceted dimensions of Bornean Clouded Leopard study, in particular at Pulong Tau National Park and its surrounding areas. The project is divided into three main components: a) population and spatial ecology of the Bornean Clouded Leopards; b) factors influencing habitat preference; and c) assessment of the resource use of the local community and the impact on the Bornean Clouded Leopard conservation. Subsequently, the empirical data could be used to formulate a realistic and practical landscape-level conservation plan to protect the native species.

Keywords: Bornean Clouded Leopard, research plan

Progress of behavioural studies on reptiles and amphibians of Sarawak

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Abstract:

Sarawak is one of the most biodiverse regions on the earth. In order to understand the biodiversity of Sarawak, my colleagues and I have conducted behavioural studies on reptiles and amphibians, which represent vertebrate diversity. For example, we conducted fieldwork in Gunung Mulu National Park and observed feeding behavior of blunt-headed snail-eating snake (*Aplopeltura boa*), which is rather obscure in terms of behaviour. We found that blunt-headed snail-eating snakes cut off the inedible operculum from snails they eat using sliding movements of the mandible. This behavior is unusual in two points. First, most of 4,000 species of snakes are not able to break their prey apart as a consequence of highly-specialized morphology and behaviour for swallowing prey whole. Second, the peculiar behaviour was made possible by radically modified jaw morphology, in which the left and right mandibles move back and forth in an independent manner. This feeding mechanism may be unique to snail-eating snakes among vertebrates. Thus, the prey-severing behaviour of the blunt-headed snail-eating snakes provides an unique example of feeding adaptations among snakes or vertebrates in general. We also investigated the availability of the snails. As a result, operculate snails were much more common than non-operculate snails in the habitat of the snake. Therefore, the blunt-headed snail-eating snakes presumably have gained a lot of new feeding opportunities by the behavioral innovation. I also report other findings from our recent researches, including those from our latest fieldwork in Santubong National Park and Lambir Hills National Park last month, and discuss how such information can be used to interpret and protect biodiversity.

Keywords: Reptiles, Amphibians, Animal behaviour

Curation of insect specimens for a study of population dynamics of Carabid beetles

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Abstract: Curation is activities related to assembling, managing, and presenting collections. For biological specimens managing the collections means not only keeping them in a good condition but also sorting and labeling them and digitalizing the specimen's ID with other related information, for example DNA data and photos. Many insect specimens can be easily collected with traps whereas lab work after field collecting (sorting, labeling, and data entry) is time-consuming and researchers normally handle only their target taxa and just keep the remaining samples, which results in many unsorted and unlabeled specimens being deposited. However, these unsorted specimens also have great scientific value. I have been sorting and labeling carabid beetles which were collected monthly in Lambir Hills national park for over 6 years and will show the six-years population dynamics of the carabid beetles. I also would like to introduce a high-accuracy digital microscope that can facilitate data digitalization by creating high-resolution focus-stacking photos very quickly.

Keywords: Curation, high-resolution focus-stacking photos, Carabidae, population dynamics

Identification of tree age and growth rates by using xylem $\Delta^{14}\text{C}$ in aseasonal tropical forests

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Abstract: The identification of the age and growth of each tree from its rings has been difficult in aseasonal tropical rain forests, because they are not formed clearly due to no climate seasonality. Tree growth history, however, provides important information for us about response from trees and forests to past environmental changes including logging and global warming. This study was designed to establish a new technique and check its accuracy for the determination of tree growth rates and ages from radiocarbon (^{14}C) concentrations in xylem tissue by using a drastic decrease in ^{14}C content in atmospheric CO_2 after the Nuclear Test Ban Treaty of 1963. We selected 23 individuals of 12 species in 6 families in Pasoh Forest Reserve in Malaysia. Their stem diameters at breast height (DBH) had been recorded continuously since 1969. Wood core samples were collected from each individual and ^{14}C concentrations were measured at 2 to 5 points in the core where xylem was probably formed between 1969 and 2000 based on the past DBH records. And we then estimated the growth rate from the xylem formation years determined by ^{14}C dating and the past records. As a result, we found a significant positive relation between the two growth rates determined by ^{14}C dating and calculated from DBH data respectively. This has demonstrated that we can identify the growth rate of each tree even in aseasonal tropical rain forests with high accuracy by conducting ^{14}C analyses of xylem. Moreover, we could use this method for the dating of tropical secondary forests after the abandonment of shifting cultivation with high accuracy in Sarawak.

Keywords: Aseasonal tropical rain forest, Radiocarbon dating, Tree growth rate, Long-term ecological data, Tropical secondary forest

Related publication: Ichie, T., Igarashi, S., Yoshihara, R. et al. Verification of the accuracy of the recent 50 years of tree growth and long-term change in intrinsic water-use efficiency using xylem $\Delta^{14}\text{C}$ and $\delta^{13}\text{C}$ in trees in an aseasonal tropical rainforest. *Methods Ecol Evol*, 13, 1135-1147 (2022). <https://doi.org/10.1111/2041-210X.13823>

Press release (Japanese Only)

高知大学 [年輪がない熱帯樹木の過去 50 年間の成長量や生理的応答を高精度に特定
～気候変動の影響解析や熱帯雨林の保護・管理手法の開発に期待～](#)

JIRCAS [過去 50 年間の気候変動により熱帯雨林樹木の成長や水利用効率が変化した](#)

New locality and bud growth of the world biggest flower, *Rafflesia tuan-mudae*, in Naha Jaley, Sarawak, Malaysia

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Abstract: The paper which already published in TROPICS described a new *Rafflesia* population was found in Naha Jaley, Sarawak, in 2012. This study aimed to identify this *Rafflesia* species and investigate its bud growth. First, we described the flower characteristics and compared them with *Rafflesia keithii* and *R. tuan-mudae*, which are candidate species for the flower. Also, we investigated the phylogenetic position of this *Rafflesia* within Rafflesiaceae using DNA analysis. To estimate bud growth curve, we observed bud development from April 2013 to November 2013 in the field. Based on morphological comparisons and phylogenetic analysis, we confirmed the newly discovered population of the *Rafflesia* at Naha Jaley was *R. tuan-mudae*, which is the new locality of the species at the most Eastern side of the known distribution for this species. The results indicated that absolute growth rate was greater in larger buds. We also estimated that it took a year to bloom from the initial bud stage. The mortality in one of our sites was very high, with more than 80% of buds dead prior to flower opening. This flower would be vulnerable to extinction due to their extraordinary characteristics and anthropogenic effects. Finally, we discussed how *Rafflesia* populations in Naha Jaley can be conserved both in-situ and *ex-situ*.

Keywords: discovery, bud development, phylogenetic analysis, morphological comparison, *Rafflesia keithii*

Related publication: Diway B, Yasui Y, Innan H, Takeuchi Y. 2022. New locality and bud growth of the world biggest flower, *Rafflesia tuan-mudae*, in Naha Jaley, Sarawak, Malaysia. TROPICS 30 (4): 71–82.

<https://doi.org/10.3759/tropics.MS21-14>



The Japan Society of Tropical Ecology
日本熱帯生態学会

ISSN 0915-615X

Press release & related articles

In Japanese

国立環境研究所 [世界最大の花・ラフレシアの新産地とその生態の解明 地域社会による生息域内保全の促進に期待](#)

JST news 2022 年 5 月号 NEWS & TOPICS [ラフレシア 開花直前に急成長、花芽の 8 割は枯れる](#)

In English

JST Science Japan [Rapid growth directly before flowering, 80% of buds wither: Clarifying the ecology of *Rafflesia*, one of the largest flowers in the world](#)

In Chinese

客観日本 [世界上最大的花—大王花的生态特性：开花前快速生长，80%的花芽会枯萎](#)

Mimicry constraints on the jumping and prey-capturing abilities of ant-mimetic jumping spiders (Myrmarachne, Salticidae) - Through the Looking-Glass: reflection of ant-diversity in ant-mimics

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2 School of Human Sciences, Kobe College, Hyogo, Japan.

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Abstract: Ants show enormous abundance and species diversity in the tropics, and the high diversity of ant-mimics is also found in the regions. If the species richness among ant-mimics has been promoted by the ant biodiversity, there should be a correlation between diversification of models and mimics. To assess this assumption, we have long investigated how ant biodiversity is reflected in ant spider biodiversity in the tropical forests of Sarawak, Malaysia. In tropical forests, *Myrmarachne* (Salticidae) is the most striking example of ant mimicry, all species of which bear a striking resemblance to different ant species. Accurate morphological ant mimicry by *Myrmarachne* jumping spiders confers strong protective benefits against predators. However, the slender and constricted ant-like appearance seems to impose costs on hunting ability because their jumping power to capture prey is obtained from hydraulic pressure in their bodies; however, the assumption has remains to be sufficiently investigated. We compared the jumping and prey-capturing abilities of seven *Myrmarachne* species and non-mimetic salticids collected from tropical forests in Malaysian Borneo and northeastern Thailand. We found that the mimics had significantly reduced abilities compared with the non-mimics. The use of geometric morphometric techniques

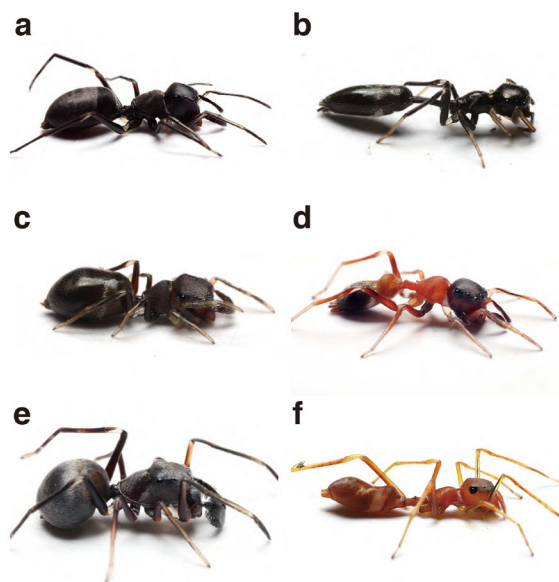


Figure Studied species of *Myrmarachne* ant-mimetic jumping spiders, except *M. malayana*. (a) *Myrmarachne acromegalis*, (b) *M. cornuta*, (c) *M. hashimotoi*, (d) *M. melanocephala*, (e) *M. maxillosa*, and (f) *M. plataleoides*. (Photo credit: Corresponding author).

revealed that the reductions were strongly associated with the morphological traits for ant mimicry and the lower abilities were found in Myrmarachne species with a more narrowed form. These results indicate the hunting performances are constrained by the morphological mimicry and provide a new insight into understanding the cost–benefit balance of accurate mimicry.

Keywords: Ant mimicry, Tropical forest, Biodiversity creation, Mimicry constraints, Southeast Asian tropics

Related publication: Hashimoto, Y., Endo, T., Yamasaki, T. et al. Constraints on the jumping and prey-capture abilities of ant-mimicking spiders (Salticidae, Salticinae, Myrmarachne). Sci Rep 10, 18279 (2020). <https://doi.org/10.1038/s41598-020-75010-y>

Press release (Japanese Only)

兵庫県立人と自然の博物館 [アリそっくりに擬態するアリグモ属が、擬態によって跳躍力や獲物の捕獲能力を低下させていることを発見](#)

JST トピックス [そっくり過ぎると損もする ～ 蟻そっくりに擬態するアリグモ属は、擬態によって本来の跳躍力や捕食能力が低下していることを発見（マレーシアで実施するSATREPSプロジェクトより）](#)

Recent Progress of Systematic Studies on Amphibians and Reptiles from Sarawak

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Abstract: Recent vigorous and intensive field surveys combined with advanced molecular and acoustic analyses have increased descriptions of new species of amphibians and reptiles in Sarawak in the last decade. Most of the new species are cryptic species but discovering completely new taxa is also known. Probably, this species increment will continue for more decades. In order to complete the herpetofaunal survey over Sarawak, we must survey not only unexplored areas remained but also unexplored habitat even in well-known national parks and human settlement areas. In this presentation, I introduce some recent taxonomic studies on Sarawakian amphibians and reptiles, especially focusing on the achievements of our group of the Japan Research Consortium for Tropical Forests, and the result of our latest survey in the Santubong National Park in this August. Finally, I briefly discuss on future strategy and schedule on the inventory of amphibians and reptiles in Sarawak.

Keywords: inventory, amphibians, reptiles, Santubong, Sarawak

Biodiversity survey manual: PUBS-SATREPS

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Abstract: Under the SATREPS-PUBS project, we have just started to conduct comprehensive surveys on biodiversity in protected areas in Sarawak (SBPS) to reveal gamma diversity of plants, fungi, insects, amphibians, reptiles, and mammals there. In parallel with the SBPS, we are now preparing manuals on biodiversity survey in the field for each target group to promote the biodiversity survey in Sarawak. This manual will be organized as follow; introduction, plants/vegetation (a standardized belt-transect survey method, Permanent Sample Plot (PSP), tree census in tropical secondary forests, *Macaranga*), insects (wild bees, termites, light trap, flight intercept trap, malaise trap), fungi (ectomycorrhizal fungi, epifoliar fungi, polypore fungi), vertebrates (reptile, amphibian, confiscated wildlife body parts) and DNA analysis (sequence data processing using the Claident software). In this presentation, I will explain the contents of each items by showing an example of the manual on a standardized belt-transect survey method to record the local flora. I hope this manual will help those who will start to collect samples and data through field work and to conduct molecular experiment for the assessment of biodiversity in the tropical forests of Sarawak.

Keywords: field survey, National Parks, SBPS, textbook

Digitalization on biodiversity studies: specimen collections and plant phenology observation

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Abstract: Digitalization of biodiversity data is fundamental to actively proceed the biodiversity studies. We have tried to make the digitalization and the databasing for (1) the 86 insect type specimens (including 44 holotypes) that were mainly collected from Lambir Hills National Park (LHNP) and have been kept in Kuching Insectarium of Forest Department Sarawak, and (2) the five thousand plant specimens that have been kept in the laboratory in LHNP. The first step of the procedure was the preservation of specimens in the proper way at the insectarium/herbarium. Then, entering the information of specimen label into the database was required. The conversion of specimen data from analog to digital signals includes photography of the specimens. To capture the specimen images, we used digital microscope camera and flatbed scanner for the mounted insects and the plant sheets, respectively (Fig. 1). We built the database of the label information with Microsoft Excel, while we introduced Claris FileMaker to combine the database with the specimen images. It enables researchers who need the detailed information of a specimen to access them from remote location. In addition to the specimen databases, we developed the application for the observation of plant phenology with Claris FileMaker. By using the app with tablet device, field observation is immediately recorded as digitalized data and observers get the details of targeted plants on the site. The system could be applied to enhance the biodiversity information that are provided for visitors at national parks ([ecotourism](#)). Moreover, the visitors would be able to participate in the research activity ([citizen science](#)).

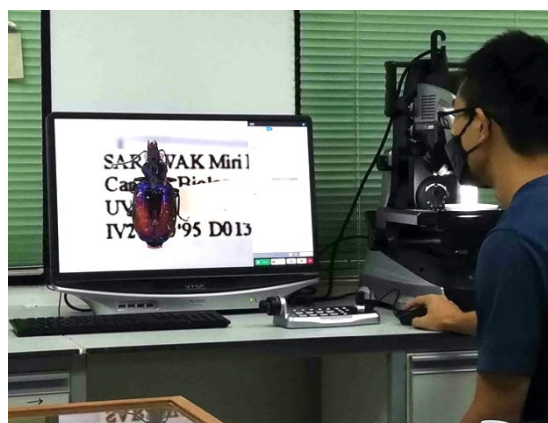


Fig. 1 Specimen image capture by using digital microscope.

Keywords: Database, herbarium, insectarium, curation, high resolution image

Toward the active use of high throughput sequencing in Sarawak

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Abstract: High-throughput sequencing (HTS), which is known more commonly as next-generation sequencing (NGS), enables us to sequence DNA and RNA much more efficiently and cheaply than an older technology. Thus, the HTS technology has been widely used in the field of biology since its initial introduction. In particular, the Illumina HTS platforms, such as the HiSeq and MiSeq, are known as powerful tools for improving our understanding about biodiversity, taxonomy, ecology, evolution and biogeography of many organisms. One of the most important goals in our project is to make active use of the HTS technology for unravelling the biodiversity of organisms inhabiting tropical rainforests in Sarawak, which is one of the most biologically diverse terrestrial ecosystems in the world. To achieve this goal, two sets of the HTS platform (the Illumina MiSeq) were recently introduced in Sarawak, and they are ready to use now. From September to October in 2022, the training course was held in Kyoto University to give the master's students from Sarawak to learn how to perform the molecular experiments, the sequence data processing and the statistical analyses regarding the HTS. In this presentation, I talk about the current state of readiness for active use of HTS for biodiversity studies in Sarawak.

Keywords: biodiversity, DNA barcoding, high-throughput sequencing, next-generation sequencing.

System development for wildlife tourism and conservation in protected areas with rainforests

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Abstract: Southeast Asia has rich biodiversity including charismatic mammal species, however it has made a limited contribution to protected area (PA) management and conservation compared with ones in Africa. So far we have examined feasibility of wildlife tourism for biodiversity conservation in national parks with rainforests using camera trapping. Here we introduce a design of GIS database system for wildlife tourism management and conservation in PAs. The GIS database system consists of three parts: data uploading and metadata extraction, data processing and analysis, and data visualization and sharing with users. Data retrieving including processing massive amount of data is often a limiting factor rather than data collection. Therefore, a user-friendly, but universal and standardized system is necessary to manage, store, classify and share massive amount of data obtained by camera trapping in PAs. We have developed a user interface and tools to facilitate video metadata extraction (date, time, camera setting, and video number) (Mammal-GO). We also have been developing an automated video data analysis tool. In addition to a machine-learning tool for species identification, a method to eliminate non-target recordings without having to watch the recordings has been developing to reduce workload for species identification. In the presentation, we discuss feasibility of the system, and data management policy to treat and release secret information of endangered species in the data management system as well.

Keywords: Camera trapping; Conservation; Cyber-infrastructure for PA management; Rainforests; Wildlife